THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VII.—No. 158.

THE BRITISH ASSOCIATION.

THE forty-ninth annual meeting of the British Association was opened on Wednesday, August 20th, at Sheffield. During the afternoon there was a meeting of the general committee, the retiring president, Mr. W. Spottiswoode, being in the chair, and it was announced that for the future convenience of members that the books belonging to the Association would be henceforth deposited in the library of the University of London, Burlington House. Among other matters there was reference to the efforts made by the Association with a view to the improvement in the Patent Law, efforts which had taken effect in the withdrawal of the new patent bill as it stood; and electricians will be interested to learn that Prof. Hughes is one of the new members of council elected.

The great event of the day was, of course, the address of the new president, Prof. G. J. Allman, M.D., the eminent biologist, which was delivered in the Albert Hall at eight o'clock in the evening, before a distinguished company of ladies and gentlemen. Dr. Allman departed from the usual custom in selecting the topic of his discourse; and, instead of presenting a popular digest of the most conspicuous discoveries of the past year, he confined himself to an exposition of all that is known about the general nature of living matter, and the phenomenon of vitality. For this reason, it will be unnecessary for us to publish his address in its entirety, and we will, therefore, content ourselves with a sketch of its main features.

The physical basis of life is, as is well known, the gelatinous substance, termed protoplasm by Mohl, and sarcode by Dujardin. It is essentially an albumenoid body, and is chemically composed of oxygen, carbon, hydrogen, and nitrogen. In appearance it is a tenacious, "glairy" liquid, resembling the white of a raw egg, and if it be watched under the microscope, it will be seen to be in spontaneous movement. It is the fundamental matter of both animal and vegetable organisms; and is to be met with in probably every part of the world, even at the bottom of the ocean.

"A quantity of a peculiar slimy matter," says Dr. Allman, "was dredged in the North Atlantic by the naturalists of the exploring ship *Porcupine* from a depth of from 5,000 to 25,000 feet. It is described as exhibiting, when examined on the spot, spontaneous movements, and as being obviously endowed with life. Specimens of this, preserved in spirits, were examined by Prof. Huxley, and declared by him to consist of protoplasm, vast masses of which must thus in a living state extend over wide areas of sea bottom. To this wonderful slime Huxley gave the name of *Bathybius Haeckelii*. Bathybius has since been subjected to an exhaustive examination by Professor Haeckel, who arrives at the conviction that the bottom of the open ocean, at depths below 5,000 feet, is covered with an enormous mass of living protoplasm, which lingers there in the simplest and most primitive condition, having as yet acquired no definite form. No law of morphology has as yet exerted itself in this formless slime. Even the simplest individualisation is absent. We have a living mass, but we know not where to draw its boundary lines; it is a living matter, but we can scarcely call it a living being. Other minute lumps of protoplasm found in the fresh waters in the neighbourhood of Jena may be compared to minute detached pieces of Bathybius. Haeckel has seen them multiplying themselves by spontaneous division into two pieces, which, on becoming independent, increase in size, and acquire all the characters of the parent."

Passing on to the next stage in the development of protoplasm, the lecturer described the amœba, which consists of a definite mass of protoplasm having a nucleus imbedded in it. The amœba is an elementary "cell" or unit of life. It feeds, multiplies copies of itself, and moves about spontaneously, playing an important part in the history of the world, for the "ooze" of the Atlantic sea-bed, on which many submarine cables lie, and the chalk of our quarries is the gathered remains of countless amœba skeletons and cases. On rising from this first stage of organisation we find cell added to cell, until many millions of such units become associated in a single organism where each cell, or each group of cells, has its own special work, and all combine to act together for the welfare of the whole.

"The distribution of labour, however, is not a uniform one, and we are not to suppose that the work performed by each cell is but a repetition of that of every other. For the life processes, which are accumulated in the single cell of the unicellular organism, become, in the more complex organism, differentiated, some being intensified and otherwise modified and allocated to special cells, or to special groups of cells, which we call organs, and whose proper duty is now to take charge of the special processes which have been assigned to them. In all this we have a true division of labour—a division of labour, however, by no means absolute; for the processes which are essential to the life of the cell must still continue common to all the cells of the organism."

That there is no essential difference between the protoplasm of plants and that of animals—that, in short, there is no duality of life—is rendered evident by a variety of proof. For example, motor phenomena are not confined to animals, for sensitive plants move spontaneously. In plants, carbonic acid is decomposed in the leaves, which are its lungs, by those cells which contain green granules of chlorophyle, when under the influence of light: and the function of assimilating the carbon is

relegated to distinct cells which lie deeper in the plant, and are therefore removed from the light; while oxygen is exhaled by the leaves. In animals, we are taught that the process of respiration is the reverse of this, carbon being discharged from the lungs in combination with oxygen as carbonic acid. But we now know that in some of the lower animals, such as the Green Hydra, certain infusoria, planariæ, and worms, chlorophyle is formed in their protoplasm, and, probably, always acts here under the influence of light as it does in plants. On the other hand, it has been shown by Schützenberger that fresh yeast, placed in water, breathes like an aquatic animal, disengaging carbonic acid, and causing the oxygen contained in the water to disappear. Further, it has been shown by Claude Bernard that sensitive plants can be put into a state of anæsthesia by means of chloroform or ether, so as to lose all power of shrinking at the touch, and that germination and fermentation are completely suspended by the same agents. In fine, all recent biological research has brought out more and more clearly that the life of the animal and the life of the plant are in all essential points identical.

We cannot do better than give the remainder of Dr. Allman's extremely interesting address in his own words :—

"I have thus endeavoured to give you, in a few broad outlines, a sketch of the nature and properties of one special modification of matter, which will yield to none other in the interest which attaches to its study, and in the importance of the part allocated to it in the economy of nature. Enough has been said to convince you that, in protoplasm, we find the only form of matter in which life can manifest itself, and that, though the outer conditions of life—heat, air, water, food—may all be present, protoplasm would still be needed, in order that these conditions may be utilised, in order that the energy of lifeless nature may be converted into that of the countless multitudes of animal and vegetable forms which dwell upon the surface of the earth, or people the great depths of its seas. We are thus led to the conception of an essential unity in the two great kingdoms of organic nature—a structural unity, in the fact that every living being has protoplasm as the essential matter of every living element of its structure, and a physiological unity in the universal attribute of irritability which has its seat in this same protoplasm, and is the prime mover of every phenomenon of life. We have seen how little mere form has to do with the essential properties of protoplasm. This may shape itself into cells, and the cells may combine into organs in ever-increasing complexity, and protoplasm force may be thus intensified, and, by the mechanism of organisation, turned to the best possible account; but we must still go back to protoplasm as a naked, formless plasma, if we would find—freed from all non-essential complications—the agent to which has been assigned the duty of building up structure, and of transforming the energy of lifeless matter into that of living. To suppose, however, that all protoplasm is identical where no difference, cognisable by any means at our disposal can be detected, would be an error. Of two particles of protoplasm, between which we may defy all the power of the microscope, all the resources of the laboratory, to detect a difference, one can develope only to a jelly-fish, the other only to a man, and one conclusion alone is here possible—that deep within them there must be a fundamental difference which thus determines their inevitable destiny, but of which we know nothing, and can assert nothing beyond the statement that it must depend on their hidden molecular constitution. In the molecular condition of protoplasm there is probably as much complexity as in the disposition of organs in the most highly differentiated organisms, and between two masses of protoplasm indistinguishable from one another there may be as much molecular difference as there is between the form and arrangement of organs in the most widely separated animals or plants. Herein lies the many-sidedness of protoplasm: herein lies its significance as the basis of all morphological expression, as the agent of all physiological work, while in all this there must be an adaptiveness to purpose as great as any claimed for the most complicated organism. From the facts which have been now brought to your notice there is but one legitimate conclusion—that life is a property of protoplasm. In this assertion there is nothing that need startle us. The essential phenomena of living beings are not so widely separated from the phenomena of lifeless matter as to render it impossible to recognise an analogy between them; for even irritability, the one grand character of all living beings, is not more difficult to be conceived of as a property of matter than the physical phenomena of radial energy. It is quite true that between lifeless and living matter there is a vast difference, a difference greater far than any which can be found between the most diverse manifestations of lifeless matter. Though the refined synthesis of modern chemistry may have succeeded in forming a few principles which until lately had been deemed the proper product of vitality, the fact still remains that no one has ever yet built up one particle of living matter out of lifeless elements—that every living creature, from the simplest dweller on the confines of organisation up to the highest and most complex organism, has its origin in pre-existent living matter—that the protoplasm of to-day is but the continuation of the protoplasm of other ages, handed down to us through periods of indefinable and indeterminable time. Yet with all this, vast as the differences may be, there is nothing which precludes a comparison of the properties of living matter with those of lifeless. When, however, we say that life is a property of protoplasm, we assert as much as we are justified in doing. Here we stand upon the boundary between life in its proper conception, as a group of phenomena having irritability as their common bond, and that other and higher group of phenomena which we designate as consciousness or thought, and which, however intimately connected with those of life, are yet essentially distinct from them. When a thought passes through the mind, it is associated, as we have now abundant reason for believing, with some change in the protoplasm of the cerebral cells. Are we, therefore, justified in regarding thought as a property of the protoplasm of these cells, in the sense in which we regard muscular contraction as a property of the protoplasm of muscle? or is it really a property residing in something far different, but which may yet need for its manifestation the activity of cerebral protoplasm? If we could see any analogy between thought and any one of the admitted phenomena of matter, we should be bound to accept the first of these conclusions as the simplest, and as affording a hypothesis most in accordance with the comprehensiveness of natural laws; but between thought and the physical phenomena of matter there is not only

no analogy, but there is no conceivable analogy; and the obvious and continuous path which we have hitherto followed up in our reasonings from the phenomena of lifeless matter through those of living matter, here comes suddenly to an end. The chasm between unconscious life and thought is deep and impassable, and no transitional phenomena can be found by which, as by a bridge, we may span it over; for even from irritability, to which, on a superficial view, consciousness may seem related; it is as absolutely distinct as it is from any of the ordinary phenomena of matter. It has been argued that because physiological activity must be a property of every living cell, psychical activity must be equally so, and the language of the metaphysician has been carried into biology, and the 'cell soul' spoken of as a conception inseparable from that of life. That psychical phenomena, however, characterised as they essentially are by consciousness, are not necessarily co-extensive with those of life, there cannot be a doubt. How far back in the scale of life consciousness may exist we have as yet no means of determining, nor is it necessary for our argument that we should. Certain it is that many things, to all appearance the result of volition, are capable of being explained as absolutely unconscious acts; and when the swimming swarm spore of an alga avoids collision, and by a reversal of the stroke of its cilia, backs from an obstacle lying in its course, there is almost certainly in all this nothing but a purely unconscious act. It is but a case in which we find expressed the great law of the adaptation of living beings to the conditions which surround them. The irritability of the protoplasm of the ciliated spore responding to an external stimulus sets in motion a mechanism derived by inheritance from its ancestors, and whose parts are correlated to a common end—the preservation of the individual. But even admitting that every living cell were a conscious and thinking being, are we therefore justified in asserting that its consciousness, like its irritability, is a property of the matter of which it is composed? That consciousness is never manifested except in the presence of cerebral matter, or of something like it, there cannot be a question; but this is a very different thing from its being a property of such matter in the sense in which polarity is a property of the magnet, or irritability of protoplasm. I know that there is a special charm in those broad generalisations which would refer many very different phenomena to a common source. But in this very charm there is undoubtedly a danger and we must be all the more careful lest it should exert an influence in arresting the progress of truth, just as at an earlier period traditional beliefs exerted an authority from which the mind but slowly and with difficulty succeeded in emancipating itself. But have we, it may be asked, made in all this one step forward towards an explanation of the phenomena of consciousness or the discovery of its source? Assuredly not. The power of conceiving of a substance different from that of matter is still beyond the limits of human intelligence, and the physical or objective conditions which are the concomitants of thought are the only ones of which it is possible to know anything, and the only ones whose study is of value. We are not, however, on that account forced to the conclusion that there is nothing in the universe but matter and force. The simplest physical law is absolutely inconceivable by the highest of the brutes, and no one would be justified in assuming that man had already attained the limit of his powers. Whatever may be that mysterious bond which connects organisation with psychical endowments, the one grand fact—a fact of inestimable importance—stands out clear and free from all obscurity and doubt, that from the first dawn of intelligence there is with every advance in organisation a corresponding advance in mind. Mind as well as body is thus travelling onwards through higher and still higher phases; the great law of evolution is shaping the destiny of our race; and though now we may at most but indicate some weak point in the generalisation which would refer consciousness as well as life to a common material source, who can say that in the far off future there may not yet be evolved other and higher faculties from which light may stream in upon the darkness, and reveal to man the great mystery of Thought.

ELECTRICAL SCIENCE AT THE BRITISH ASSOCIATION.

Some New Instruments, recently constructed for the Continuation of Researches on Specific Inductive Capacity.

By J. E. H. GORDON, Asst. Sec. Brit. Assoc.

IN this paper the author illustrated his observations by the exhibition of a miniature five-plate induction balance, similar in principle to the large balance shown at the Dublin meeting of the Association, but intended for the examination of crystals and other precious substances, which cannot be obtained in sufficiently large quantities for the balance; also a gauge for measuring the thickness of the dielectric plates to 1-10,000 inch, and a new form of quadrant electrometer for use with the small induction balance was shown. The capacity of the smaller plates of the little induction balance was so minute, that, when they were attached to the quadrants of the electrometer of ordinary construction (Elliott pattern), disturbances in them produced hardly any effect on the needle, on account of the much greater capacity of the quadrants of the electrometer. In order to construct an electrometer, whose quadrants should have very small capacity, and which should yet be very sensitive, Mr. Gordon had arranged the quadrants as pieces of a flat disc, only one inch in diameter, with the edges bent round them, so that the needle was acted on by both the upper and lower surfaces and the outside edge.

Mr. Gordon also exhibited a new rapid commutator, which was invented by Professor Cornu, of the Ecole Polytechnique, Paris. It could be used with either the large or small induction balance on the one hand, and with a Holtz machine or battery of 500 or more cells on the other. It reverses the electrification of the plates of the balance eighteen times per second, and between each reversal, short circuits, and puts to earth both poles of the induction balance, and both poles of the battery. By altering two screws it can be arranged to short circuit, and put to earth the poles of the induction balance only and to insulate the battery poles.

Secular Changes in the Specific Inductive Capacity of Glass.

By J. E. H. GORDON, Asst. Sec. Brit. Assoc.

The object of this paper was to describe the result of certain experiments made by the author by a method which has already been described before this section. The conclusion arrived at was

that in the course of a year and a half an actual change had taken place in the glasses, which was shown by a considerable real increase in their specific inductive capacities. To complete our knowledge of this new phenomenon, however, it was considered that a series of monthly observations was required extending over a period of several years. These experiments had some importance as regards Professor Clerk Maxwell's electro-magnetic theory of light. Mr. Gordon had recently suggested that it was quite possible that the relations between electric induction and light exists—namely, that they are disturbances of the same ether, but that there is some unknown disturbing cause affecting the electric induction. Possibly a clue to the nature of this disturbing cause might be found in the fact that the specific inductive capacities were affected by some of the changes which chemists assert are constantly occurring in glasses, but that these changes do not affect the refractive indices.

Electricity as a Motive Power.

By Prof. W. E. AYRTON.

Discourse delivered August 23rd, 1879, to the Working Men of England.

WE hear on all sides new complaints regarding the stagnation of trade, the competition of foreign labour, and the difficulty found in disposing of English products to other countries. Various are the remedies suggested: on the one hand we are told that protection is the cure, because our trade is now almost entirely an import one, kept up by the export of English gold, and not, as it should be, by an exchange of English commodities for foreign ones. Consequently, there are some people who say that the only way to induce other nations to lower their prohibitive import duties, so as to stop this one-sided traffic, is to cause their own goods, now freely exported to Great Britain, to hang on their own hands, and that this can be done by the English temporarily also adopting protection. On the other hand we are assured that emigration is the panacea, and that it is the strikes which ruin the country.

But while the one side is maintaining, and the other side stoutly denying, that commercial depression can be cured by legislation, we are apt, far too apt, to forget that there exists a means by which, without lessening the wage of the workman, or the profit of the master, the cost of production can be diminished, prices lowered, and the failing trade of England resuscitated.

For is it only by burning coals that we can hammer our steel, turn our grindstones, work our lathes, and propel our trains? Coal is no doubt an extremely useful servant, but it is one that here in Yorkshire costs you five shillings a ton when you want to get power out of it, about twelve shillings a ton when used for melting metals and making gas, and about ten shillings a ton when you want it to warm your houses; therefore, as Mr. Bainbridge has been so kind as to ascertain for us that roughly in Sheffield alone about 500,000 tons are used annually for the first purpose; 750,000 tons for the second; 150,000 tons for the third; and 250,000 for the last of these objects, you see there is altogether an annual consumption in this town of about one million six hundred thousand tons, costing you therefore about £790,000 every year.

It is worth while, then, considering whether this consumption of coal can, even in a small degree, be replaced by any other source of power and heat.

For example, at Ottawa, in Canada, where exist perhaps the largest wood-cutting works in the world, the logs of wood come down from the mountains, are collected in the river, lifted and placed in position on the benches, sawn into planks, and stacked; but not a pound of coal is burnt. For merely by taking advantage of the fall of water which exists at the place, a man has merely to turn on a particular water tap to perform any particular operation.

For a stock of water on a hill is, to the people in the valley, what a coal mine is to a Sheffield manufacturer. As the water runs down the hill it can turn wheels, it can work machines just as can coal as it burns in the furnace of a steam engine. You all know the water wheels round Sheffield employed to work the grindstones and the tilting hammers. The high quality of the anvils coming from your Mousehole Forge, where water power is, or was, exclusively used, would be alone sufficient to keep water power permanently before you.

On Goat Island, between the Falls of Niagara, there is a paper works, the machinery of which is worked by the Falls. But what an infinitesimal portion of the energy of these Falls is used by that single paper mill. For, in addition to the gradual slope of the river, on account of which the water acquires considerable velocity, a hundred million tons of water come tumbling down every hour, through a vertical height of 150 feet. Now the power this represents is, of course, the same as would be required by perfect pumps to pump it back again. To raise a hundred million tons of water per hour, through 150 feet, requires the expenditure of nearly seventeen million horse-power; and this could only be produced, with even good steam engines having much above the average efficiency, burning, say 3 lbs. of coal per hour per horse-power, by an annual expenditure of about two hundred million tons of coal, which is about equal to the total consumption of coal throughout the whole world. And if it be remembered that there exist in the world other waterfalls besides Niagara, that we have also innumerable rapidly flowing rivers, the important fact well known to scientific men, but one which it is difficult to induce the world at large to grasp, stares us in the face—that we obtain, in a laborious way from the depths of the earth, the power we employ, and we let run to waste, every hour of our lives, many, many times as much as we use.

But it is not every manufactory that is situated directly over a stream, or even near a stream; and even when that is the case, as in Sheffield, you find streams are sometimes fickle, the tilting cannot be regulated with the same nicety as with a steam hammer—the natural order of things is reversed; water gives way to fire.

But were it possible, without water courses or cumbrous mechanism, to transport direct the energy of the mountain torrent, then machines in the very heart of a town could be worked as economically as those close to cataracts.

Again, even in a perfectly flat country, where waterfalls are unknown, the question of economic transmission of energy has no less interest. For you know that large steam engines can be worked much more economically than small ones. If, for example, I have a steam engine of many hundred horse-power, it can be worked by an expenditure of about two, or two-and-a-half, pounds of coal per horse power per hour, or, at the present price in Sheffield for steam coal, five shillings per ton, the best steam engines, if they be very large, can be worked at considerably less than one farthing

per hour. But if a man has a small grindstone requiring, say one horse-power to work it, and if he uses a small steam engine for this purpose, then instead of costing him less than twopence per day of eight hours' work, he will probably have to pay a shilling a day, in addition to the expense and trouble of getting up the steam; so that if he only uses the small steam engine occasionally, it will be hardly worth while going to the expense of having one at all. If, however, he could have transmitted to him, just at the time he might require it, a small amount of energy at, say, one halfpenny per hour per horse-power, which would be three or four times the actual cost of production of the horse-power with a very large steam engine, and if he could turn off the power like gas when he did not want it, so that one single hour's work with a one horse power grindstone cost really only one halfpenny, how many of the smaller workmen of Sheffield would be glad to avail themselves of such a facility.

But you will say in our large factories, in our huge cotton spinning mills in Manchester for example, we do use very big steam engines, and therefore this transmission of energy cannot produce any great gain there. Undoubtedly, these steam engines are fairly efficient, because they are so large; but what about the enormous mass of shafting used to connect this single engine with all the stories of the factory and with all the machines in each story? Why, the waste of power in friction in this shafting is so great that, in spite of the extreme inefficiency of small engines, it has been proposed as an economical measure, to replace the one large steam engine by many small ones, each driving two or three machines direct.

It might, at first sight, appear that the water already brought to our houses for drinking and for cleansing purposes, might be also used there for working small turbines or waterwheels, and I have heard this suggested as a possible means of utilising a natural source of power. But this is one of those delusions into which over sanguine people are liable to fall. For there are very few towns where the working pressure of water in the streets is more than able to raise it to a height of 100 feet.

Now 1 cubic foot of water weighs 62½ lbs.
therefore 1 ,, ,, ,, ,, descending 1 ft. per minute does approximately 1 foot pound of work per second.
That is—5½ cubic feet of water per minute } for every 100
Or— 330 ,, ,, ,, ,, ,, hour } feet head
produce approximately 1 horse-power.

Some allowance must, however, be made, for the fact that our best turbines have at the most only an efficiency of 0·8, that is waste 20 per cent. of the power. We may, therefore, say that practically about

450 cubic feet of water per hour } for every 100 feet
Or—2,700 gallons ,, ,, ,, ,, } head
produce 1 horse-power.

But even in places like Sheffield, where the supply of water is large, the minimum cost in the town, when more than seventy millions of gallons are used annually, is not less than 6d. per 1,000 gallons. Consequently, with water at a pressure of 100 feet, it would cost about one shilling and fourpence per horse-power per hour.

In Sheffield, where the working pressure of the water in the lower parts of the town is also unusually high, being not less than 130 lbs. per square inch, or 300 feet head, it would be possible to produce work by small turbines at about fivepence per horse-power per hour, but this of course cannot be compared with less than one farthing per horse-power per hour, the cost of working very large, good, steam engines.

In our poverty and depression, our old servant, coal, is beginning to desert us, and to demand a higher price than we can give. Water, a yet older handmaid, refuses to work at all in our houses, except for extravagant payment. Where is it that we must turn for help? Where can we find the carrier that will, at a small cost, transport our motive power over long distances?

It is to electricity we must look for an answer to this question. It is to that fleet, subtle, messenger to whom we trust the carrying of our news that we must trust the carrying of our motive power.

To explain better what I mean:—When I turn the handle of this machine, my muscular energy is turned into electricity. This electricity is conveyed by the two wires before you to the small motor at the other side of the Hall, where it is converted back again into work. I put in work then here and I get it out again at a distance, without any shafting, straps, or pipes connecting the two places.

In exactly the same way, but on a much larger scale, Mr. Wilson will be so kind as to polish a knife with motive power supplied by Messrs. Walker and Hall, of Howard Street, and conveyed here electrically, by wires suspended to the spire of St. Paul's church, and crossing the streets as you see them in this diagram.

This other diagram shows you exactly how the machines in Howard Street, and these on this platform are electrically connected together.

Now these machines that are employed for this purpose depend on two important discoveries, the first, supposed to have been made by Romanosi, in 1802, who found that an electric current could produce mechanical motion; the second discovery, made by Faraday, in 1831, who, after the most patient investigation, was at length able to prove conclusively the result that he had long felt in his own mind must certainly be true, viz., that a magnet must somehow be able to produce an electric current. The first of these discoveries may be illustrated by the following simple experiment. Here we have a vertical copper wire, through which we can send an electric current either upwards or downwards. Behind the wire there is a magnet, suspended on a horizontal axis, so that it can turn in a vertical plane. The magnet is so arranged, that usually it stands upright, but if I send a current upwards, you observe the marked end turns to your left, while if I reverse the direction of the current, the marked end turns to your right, the magnet in both cases placing itself at right angles to the wire. Now, why does the magnet move when the current flows along the wire? Because the wire with the current in it produces in the space surrounding it the same effect that would be caused by the presence of a large magnet. For if I hold this other magnet in this position, perpendicular to the suspended magnet, you see the latter one turns with its marked end towards your left hand, as it did when the current ascended; and when I reverse the position of the big magnet, the smaller one puts itself in the same position as it did when the current descended. From this you would anticipate that since an electric current can act like a permanent steel magnet, in deflecting a suspended magnet, and since a steel magnet can make this piece of soft wire into a magnet by being put near it, that an electric current will also make a piece of iron into a magnet, a result first proved experimentally by Arago. When the electric current passes through this coil of wire, wound round this iron bar, the bar acquires the power to hold up masses of nails, but the moment the current ceases the iron, as you see, loses almost, but not *quite*, instantaneously, all its magnetic properties, and the nails fall to the ground. But since, by electricity, I am able to produce sufficient pulling force to hold up bits

of iron, or, at will, cause this force to cease to act, then I must be able to do just as Newcomen did, when he made his so-called atmospheric engine.

For if we cause the attraction of this electro-magnet to pull a piece of iron, or armature as it is called, against the tension of a spring, and if, just when the iron is almost touching the electro-magnet, we interrupt the current, the spring will be able to pull the iron back again, and thus by repeating the action over and over again you see we can get an oscillating motion similar to that obtained in a single acting engine. And any oscillating motion you know can be turned into a rotatory motion by means of a crank and fly-wheel to make the crank pass the dead points. Now, the first man to make an oscillating electro-motor of this kind was a learned monk of Padua Salvator del Negro, in the year 1831. But an oscillating motion has many disadvantages, of which perhaps the most important in an electric engine is that the moving armature at the end of its stroke will be at a distance from the electro-magnet. Now the electro-magnetic attraction diminishes very rapidly as the distance increases, so that when the armature begins to approach the electro-magnet there will be very little force pulling it.

The Russian philosopher Jacobi explained this in 1834, and devised a rotatory engine in which the moving parts were not merely pieces of iron, but electro-magnets like the fixed ones. When the pole of one electro-magnet was approaching that of another due to the rotation of the apparatus, the currents were so arranged that there was attraction, but the moment the moving pole passed the fixed pole the electric current flowing round the former was reversed, so that there was attraction. An instrument such as Jacobi used may be seen working on the table, and like Jacobi's was originally intended to propel a boat. Here again I have a complete model boat driven by an electro-magnetic engine, with galvanic battery in the boat. A third electro-motor is working a Howe's sewing machine, while a fourth is a small engine running round on a pair of metal rails. This last would no doubt pass with the world as a mere toy, but the practical philosopher sees foreshadowed in it his dream of the future, just as Stephenson, in his "Puffing Billy," no doubt foresaw the express locomotive engine of the present day.

But after some time Jacobi abandoned his electro-motor, as the fuel cost far too much. Why then trouble you with considerations regarding electro-motors? Because we have since learnt why the old form was such an expensive producer of power, and what is the proper duty in which electro-motors should be employed.

Now, it was this very question:—Can an electric engine be made to work more economically than a steam engine that first attracted Joule of Manchester, in 1843, to commence that all-important investigation, which lasted for six years, the determination of the mechanical equivalent of heat.

Formerly, electric currents were almost entirely produced only by galvanic batteries, such as I have in my hand, in which zinc is burnt just as in the furnace of a steam engine coke is burnt. The amount of heat that could be got from burning a pound of zinc could be ascertained in the same way as the amount of heat produced by the burning of a pound of coal, but the fact that the latter was about seven times the former was of little value in the science of electro-motors, until Joule had proved that a certain quantity of heat is always equivalent to exactly the same quantity of work, no matter how the heat be produced; in fact, until Joule had arrived at that famous result which, although you know it well, will still bear repeating, that result which made the "Conservation of Energy" a law and not merely a speculation.

A quantity of water on a height, a heated body, a moving mass, two separated quantities of opposite kinds of electricity, an electric current, two chemicals which would combine if brought together, particles of attracting matter at a distance asunder, two planets in space, are examples of energy—each of the systems can be made to do work.

Now, experience shows that all these energies are convertible into heat, and that a certain quantity of each kind of energy is mechanically *exactly* equivalent to a certain quantity of any other. If a body, or if a system of bodies, possesses different kinds of energy, then as long as no energy leaves the system, or enters it from without, this sum is *perfectly constant*, no matter how one of these forms of energy may change into another form. Energy is in fact as indestructible as matter, and this law has one of its proofs in the long unsuccessful search for a perpetual motion.

Since, therefore, a pound of ordinary coal burning gives out seven times as much heat as the burning of a pound of zinc, we may say at once, that a steam engine would give seven times as much work as an electric engine for equal weights consumed, if in both cases all the heat could be turned into work; or, since zinc is about 24 times as dear as coal, that a steam engine would be about 150 times as economical as an electro-motor, worked by a battery.

But so far we have only considered the law of "Conservation of Energy." There is, however, another, and no less important, principle called the "Dissipation of Energy;" and this law tells us that although the energy of a system cannot by itself increase or diminish, yet our power to convert one form of energy into another is continually growing less, our stock of available energy is gradually failing. Our mountain lakes, our vast store of coal is practically useless until either the water is set in motion rolling down the hillside, or until the particles of the coal are set in rapid vibration as it slowly burns; energy of position, energy of chemical affinity, are of no use to the manufacturer until turned into kinetic energy or energy of motion. But from friction of various kinds, whenever energy exists in the kinetic form, some portion of it is being continually converted into heat. Whenever man or nature utilises energy it must be first turned into some kinetic form, and whatever be the aim of the special machinery employed some of this energy passes into heat. We cannot make even a clock go without regular winding up, although the only useful work done by the clock is to turn its hands at regular speeds; the earth's energy of rotation is now, like the moon's in past ages, gradually growing less, and is being converted into heat on account of tidal retardation; the earth, moon and sun, and all the planets are losing their energies of motion and relative positions, to be all ultimately turned into heat.

But at any rate it will be said there will still remain the heat, and since heat can be converted back into other forms of energy, we shall be none the worse off. But it must not be forgotten that whenever heat is produced some passes off by conduction through even our best non-conducting substances, and by radiation into space from even our best non-radiating surfaces; and this conducted and radiated heat, although it may impart some trifling warmth to unseen worlds, is for the greater part entirely lost to our universe. And even were it not so, even had we perfectly non-conducting coatings, and perfectly non-radiating surfaces,—had we, in fact, the most perfect heat engine that our study of the science of heat would lead us to believe theoretically possible, one with no friction, no loss of heat by conduction through the sides of our cylinders, and no radiation from their sur-

faces—still our power to convert heat into other forms of energy would be very limited. For if there are two bodies one hotter than the other we can employ an engine, like a steam engine, to convert part of the heat in the hotter one into some other form of energy; but the amount of heat converted, with even this ideal perfect engine, will, with such temperatures as are met with in practice, only be a fraction of what necessarily passes through the engine from the hot body to the cold, and warms up the latter; and as our whole power of conversion of heat into work depends on the difference of temperature, we lose it altogether when we have brought all parts of a system to the same temperature, no matter how high this temperature may be.

It is not, therefore, sufficient to say that the burning of a pound of coal produces seven times as much heat as the burning of a pound of zinc; but we must consider what fraction of the heat thus produced is converted into useful work in a heat and in an electric engine respectively.

As already mentioned, our most perfect steam engines can be made to produce one horse-power with the consumption of 2lbs. of coal per hour. Now, the burning of 2lbs. of coal will produce enough energy to raise 18,528,000 pounds one foot, or will produce 18,528,000 foot pounds of work. Now, one horse-power is equivalent to 1,980,000 foot pounds of work per hour, therefore, as regards the total energy in coal, even our best steam engines only utilize $\frac{1}{9}$ of it and waste $\frac{8}{9}$. But, as already mentioned, even a perfect engine cannot, with the ordinary temperature available, utilise the whole of the heat of the fuel. In fact, theory tells us that the efficiency of a perfect heat-engine, or the ratio of the work done on the maximum work obtainable from the consumption of the fuel, is equal to the ratio of number of degrees of temperature through which the steam is cooled in doing work to the highest temperature of our steam, when we take as our zero of temperature a point 460° below the ordinary zero of the Fahrenheit scale.

Now, in our best steam engines, the steam, when it begins to push the piston by expanding, has a temperature of about 300° F. and at the end of the stroke a temperature of 100° F. so that the efficiency of a perfect ideal engine working between these temperatures, is only about $\frac{1}{4}$, not so very much greater than that of best practical engines.

No great advance can be made then in a heat engine, except by making the temperature of the working substance, steam, gas, or whatever it may be, much higher. If, for example, we could raise the temperature of the working substance as high as, say, 3,000° F., the temperature of combustion, and could make it leave the engine without artificial cooling at the ordinary temperature of the air, which is, say, 60° F. then a perfect heat engine, under these conditions, would only waste about $\frac{1}{4}$ of the total energy; consequently assuming that we could, at these high temperatures, make a practical engine as good relatively to an ideal perfect engine, as we can at lower temperatures, then a practical engine would only waste $\frac{1}{4}\frac{1}{5}$ of the total energy, or would have an efficiency of about 0·84.

But, with our present knowledge, to work with steam or gas at a temperature of 3000° F. is almost as ideal as an engine with no friction, and with no loss of heat by conduction and radiation. We are, therefore, led to the conviction that as it is solely by working with steam at very high temperatures, that the efficiency of steam engines can be seriously increased, it may be well to consider whether it is not possible to economically replace the steam engine with some other form of motor.

In order to estimate the efficiency of electric engines, we must consider the discovery made by Faraday, to which I have referred. We know that motion can produce electricity with the ordinary glass electrical machine, and that the electricity so produced can in its turn set up motion, as in the pith ball telegraph worked by Sir Francis Ronalds. We know that difference of temperature can produce an electric current, and the electric current can in its turn produce heat, or difference of temperature. Consequently Faraday felt sure that, since an electric current can, as you have seen, produce a magnet, a magnet must, in some way, be able to create an electric current. But his attempts were baffled time after time; failure, failure only was the result, yet buoyed up with hope, still persevering with that dogged earnestness which is the characteristic of an Englishman, he at length arrived at this all important discovery—to produce a current with a magnet it is no use placing the magnet this way or that way relatively to the coil, but you must have *motion* of the one relatively to the other. And this coil of wire before you is the very one made by Faraday's own hands, and which he used in investigating this problem. The results obtained with it were insignificant in magnitude, but they form the foundation of all the electric lighting of the present day and of the future electric transmission of power.

To enable you to better understand the discovery of "magneto-electric induction," I have here a coil of wire in which a magnet is suspended, and free to move in a vertical plane. Attached to the magnet is a pointer to enable you to detect any motion of the magnet. Those of you who are near will see the pointer itself, while those who are at the other end of the room will see it projected on to the screen as a huge vertical black bar. The exact construction of this instrument is also shown in the large diagram.

Now, we know from our previous experiments that this arrangement will detect whether an electric current is flowing through the wire and also which way it is flowing; in fact the instrument is in principle exactly the same as the one I previously used, only, as the wire goes many times round the magnet in this second instrument, it will detect a much weaker current. To the two ends of the wire forming the current-detector are attached the two ends of the wire forming this coil. The pointer of the detector is now vertical, indicating that no current is passing; but if I rapidly move this magnet towards the coil, the pointer deflects to the left, and then comes back again to the zero position, indicating that an instantaneous electric current was set up in one direction. Now, if I rapidly remove the magnet I have in my hand, you observe the pointer makes a swing towards the right, indicating an instantaneous electric current in the opposite direction. To be quite sure that the deflections you saw produced in the suspended magnet are the results of electric currents, and are not produced by the direct attraction of the large magnet, I hold in my hand, on the suspended magnet, I make a break in the circuit of the wire so that electric currents cannot now flow; and you observe that the motions of the big magnet produce no effect whatever on the little one at this distance.

Now, we have seen that an electric current can do work, and the principle of the conservation of energy tells us that work cannot come out of nothing, therefore, my hand, in moving the magnet, must do as much work as is performed by the current. As this current is weak it would be a little difficult to measure, in a simple way, the work done by my hand; but if we take a machine for producing strong magneto-electric currents, a machine called the "magneto," or "dynamo-electric machine," then as long as the wire is incomplete so that no current can flow, you see it is quite easy for me to turn the handle, but the moment a small

piece of wire is inserted so that a current is induced, my hand is arrested—I can hardly turn the handle—I have to do work, hard work, in order to continue the motion of the machine, and that work has its equivalent in the electric current that flows, and in the heat which you see the current is producing in the piece of wire we inserted, and which has now become white hot.

But, perhaps you may say, although this is very interesting in connection with the mechanical production of electric currents, what has it to do with the comparison of steam engines with electro-motors, the object of which is not to produce currents, but work? The answer is, because every electro-motor, every instrument that is worked by an electric current, is also a magneto-electric machine, that is, can produce electric currents, and, in addition, always is producing electric currents when it is itself set in motion by one. For taking this simple form of electro-motor—where an iron armature is attracted by an electro magnet—this attraction arises from the fact that as soon as the current is started, the iron armature is first converted by induction into a magnet before it is attracted; consequently when it moves up to the electro magnet, we have the case of a magnet approaching a complete coil of wire, the result of which you now know is the production of an electric current. Now, this electric current must be in the opposite direction to the original current producing the motion, for otherwise the original current would be increased by the induced currents, therefore the armature would be pulled with more force, and the total work done by the original currents would be increased without any equivalent consumption of energy elsewhere. This induced current therefore, like all currents induced by the motion of magnets, relatively to coils of wire, *tends to stop the motion*, and must be taken into account, in calculating the efficiency of an electro-motor; in fact not only must be taken into account, but experiment shows us that it is this tendency of the electro-motor to send a back current that makes it an electro-motor at all.

This reverse current may be thus shown experimentally. I have here a battery sending a current through a Froment's electro-motor, which, as you see, can work either this pump, or this pile-driver. Now, the strength of the current, as measured by this galvanometer, is 40° when I hold the electro-motor at rest, so that it can do no work, and 30° when I allow the motor to move rapidly as you now see it doing.

When an electro-motor is worked by a *given* galvanic battery, then calculations lead us to the result that if we wish to produce the work *most economically* we must, by diminishing the load on the motor, allow its speed to increase until the reverse current it produces is only a little smaller than that sent by the battery; in fact, until the current circulating through the arrangement is very small, in which case the efficiency of the engine, or the ratio of the work it produces in a given time to the maximum work it could produce from the same consumption of material is nearly unity. If, on the other hand, we desire a *given* battery to cause the motor to do work *most quickly*, independently of the consumption of material, then calculation tells us that we ought to put such a load on the motor that its speed will send a reverse current equal to something like a half of the strength of the current the battery could send through the motor when at rest. In this case the efficiency is about $\frac{1}{2}$, or half the energy is wasted in heat.

The difference between these two considerations of maximum values must carefully be borne in mind, especially as it is usually the second—or how to obtain work *most quickly*—that has generally been taken into account, whereas, this evening, it is the other one—or how to transmit work *most economically*—that will specially engage our attention.

Now, let us consider that we work our motor in the most efficient way—that is very fast with a small load, and let us consider that by so doing the efficiency is so little short of unity that we may regard it as one, then since an electro-motor worked by a battery in which zinc is burnt is 150 times as dear as a steam engine for equal efficiencies, the best electro-motor worked by such a battery will be 33 times as dear as our best steam engines having an efficiency of $\frac{3}{4}$. We may, therefore, throw on one side at once all idea of electro-motors worked by ordinary batteries, even although the electro-motors be perfect. Now, this result is most important, since it shows not that an electro-motor as a machine is inefficient, but it tells us that attempting to drive it with a galvanic battery is the hopelessly inefficient part of the arrangement.

But if we turn to the question of using electro-motors for the transference of power, then there is no difficulty about burning zinc, and the high efficiency of such motors is all important.

For in the case of natural sources of power, such as waterfalls, we have merely to consider what amount of energy will be produced at the distant factory; will it be sufficient to repay the expense of putting up wires from the source to the factory, together with the cost of the two dynamo-electric machines, or will it be cheaper to put up and use a small steam engine having probably an efficiency of only $\frac{1}{15}$?

When the distance between the source and the motor is considerable, the cost of putting up the leading wires becomes important, and the question therefore arises, can two or more people use the same leading wires without increasing the thickness, or must the thickness of the wire be so much increased as to make the construction of two sets of leads as economical?

To this question I must beg your most careful attention, since the answer to it, which I hope I may b able to put it in the power of all of you to give, will decide whether the electric transmission of energy is a mere dreamer's fancy, or is likely to have a real commercial future.

In order to decide this let us consider what proportion of the power is lost in transmitting it by electriciity and what is lost when water is used as the carryng, agency. For convenience we will take the second question first.

Let W pounds of water flow per second out of a reservoir, along a pipe into a town, then if there was no friction whatever in the pipe, if the pipe were perfectly smooth so that the water could slip past the surface quite easily, then the work the water could do in the town would be

$$W\,H \text{ foot pounds;}$$

but experience shows that in reality this amount of work, when the pipe is straight, is diminished by at least

$$W\frac{4\,f\,l\,v^2}{d \times 64{\cdot}4}$$

where f is a number depending on the smoothness or roughness of the pipe, l the length, and d the diameter of the pipe in feet, and v the velocity of the water in feet per second with which the water flows through the pipe. The work, therefore, that the water can do in the town is only the difference between these two last quantities, or

$$W\left\{H - \frac{4\,f\,l\,v^2}{d \times 64{\cdot}4}\right\}$$

and the loss goes to slightly heat the pipe and the water. This loss will, in reality, be even greater than

what I have mentioned, as there is a certain amount of friction where the water enters the pipe at the reservoir, and additional friction at every bend of the pipe.

Now w pounds of water per second flowing, may be enough to work one man's machine, but suppose we want to increase the work done, we must, if we cannot alter the reservoir, diminish the water pressure in the town, to allow the velocity of the water and the quantity flowing per second to become greater. Suppose we double v then w will also be doubled. Double the energy will, therefore, be taken out of the reservoir, but the power furnished in the town will not be twice as great as before, since it would only be twice as great if we could both double the current and keep the pressure in the town constant; the loss, too, of power in the pipe will now be eight times as great as before, so that if we go on supplying a town in this way with motive power, the loss of energy will soon become ruinous.

But there is another way in which theoretically we can increase the power conveyed to the town, and that is by increasing the pressure at the reservoir, as well as the pressure at the town. Suppose, for example, that we double the pressure at the reservoir and increase the pressure at the town sufficiently to keep the difference the same as before, then the velocity of flow and therefore the quantity discharged will remain just the same. The waste, therefore, will not be increased, the power absorbed at the reservoir is double what it was before, while the power given out at the town is more than double what it was before, since the pressure in the town will have to be more than doubled to keep the current constant.

Such an arrangement, as far as we have gone at present, would then be a good one, since if we can much increase the pressure at the reservoir, and use at the town turbines, or water engines, working at a high pressure, we shall be able to transport any amount of power with exceedingly little loss.

Is this then the solution of the problem to transfer power economically by water? Theoretically, yes; practically, no. For when we talk of increasing the pressure at the reservoir, how are we to do it?

We must use some kind of force pump, worked either by a steam engine, having a combined efficiency of perhaps $\frac{1}{10}$ at the most, or by a considerable quantity of the water at a low pressure working a turbine which drives the force pump. Now, the combined efficiency of the pump and turbine will not be more than $\frac{8}{9}$. Taking this latter as being the larger and that assuming at the town itself we have some sort of water-motor, having an efficiency of even as much as 0·8, then the combined efficiency of the whole arrangement cannot be more than 0·32.

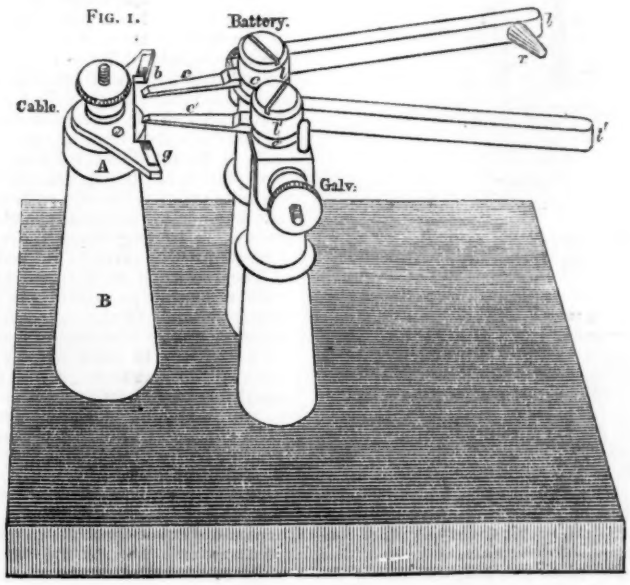
(To be continued.)

A NEW FORM OF "DISCHARGE KEY."

By J. RYMER-JONES.

THE key is so constructed that the *cable terminal* is left perfectly *free* during the period of *insulation* as shown in fig. 2—gives a very considerable length of surface, over which any leakage must pass, it being in the present case $6\frac{3}{4}$ inches in a height of only $2\frac{1}{2}$ inches; while since the portion A screws into the outer cap B, the former may be removed,

FIG. 1.

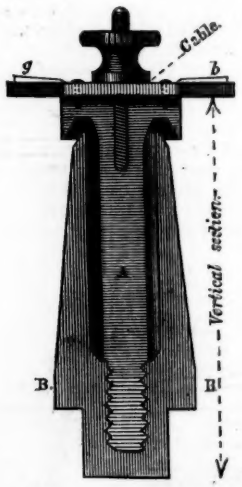


shown in fig. 1. The leakage from the key is therefore confined to the ebonite support, A B. The form of this support—a vertical section of which is when important tests are about to be made, and rubbed with glass-paper, so as to secure the advantage of a fresh surface without disfiguring the outer

polished surface. Another weak point to be found in the ordinary forms of "trigger" and "cam" discharge keys is that the length of ebonite between the hand and lever connected to the cable, when in the act of *discharging* or *insulating*, is very short, and, moreover, handling cannot but increase the surface conduction, so that the leakage by the body of the operator tends to lower the potential of the charge in a cable. The manner in which the key in question is manipulated entirely prevents this; and a further advantage is obtained by the *rubbing contacts* at *b* and *g*, which are always *firm* and *clean*.

For the above reasons the key is peculiarly well suited for tests where a high degree of insulation is essential, and especially for obtaining exact results when used in connection with a Thomson's electrometer. After A has been freshly sand-papered, and

Fig. 2.



Length of insulating surface 6¾ inches.

before it is screwed into position, a very small quantity of *paraffin oil* may be poured into B, so as to obtain the advantage of a short length of insulating surface which resists the deposition of a film of moisture. The cover form given to the top of A is to prevent dust from entering the cup B.

The movements for "charge," "insulate," and "discharge" will be readily understood from fig. 1. *l l'* are ebonite rods; their brass prolongations *c c'*, which move with them as one piece, have the under surfaces, where they rub against the platinum contacts *b* and *g*, tipped with platinum.

When *l* is deflected to the left, the end of the rod *r*, attached to it, presses against *l'*—should the latter happen to lean towards that side—and carries it over in the same direction, first breaking contact at *c' g*—if previously made—and afterwards making that at *b c*. The cable is thus *charged* by the battery.

To insulate the cable it is only necessary to move *l* back again towards the right, as in fig. 1.

To discharge the cable, press *l'* towards the right. Should *l* not already be over to the right (as in last position for *insulate*) it will be carried over with *l'*, and the contact at *b c* broken before *c'* and *g* come together, so as to discharge the cable through the galvanometer to earth. The rod *r* prevents the galvanometer and battery from both being put to the cable at the same time.

These keys, which have proved highly satisfactory for practical purposes, have been adopted by the India-rubber, Gutta-percha, and Telegraph Company, at their works at Silvertown, London, E., where they are manufactured.

[We have much pleasure in publishing the foregoing description of an instrument which certainly possesses decided advantages, and is therefore likely to commend itself to practical men for cable-testing. —ED. T. J.]

THE SIEMENS-ALTENECK ALTERNATING CURRENT DYNAMO-MACHINE.

THE general construction of this machine is shown by figs. 1 and 2, fig 1 being a longitudinal section, and fig. 2 a front view. On the base A are fixed the two side frames B, carrying each a number of electro-magnets C, C (of which 16 are shown in the drawings), and bearings for the shaft E. On this shaft is fixed a disc J, carrying a number of coils S, of elongated shape, as shown by the dotted lines in fig. 2. These coils are wound in the plane of the disc or cores D of elongated shape. The electro-magnets C have their facing polar ends extended by fixing on them trapezoidal iron plates F, and these plates and the coils S are so proportioned, that each coil has advanced over about half the width of the plate from which it is retreating. The coils of the magnets C, C are so connected that the two polar-fields facing one another are always of opposite polarity, also the polar-fields contiguous to one another are of opposite polarity, and thus the coils S, in passing through the successive fields, have alternating currents induced in them.

The collection of the currents induced in the coils S, by the passage of the latter through the magnetic fields of alternate polarity and the combination and commutation of these currents, and of such portions of them as may be employed for exciting the electro-magnets C, C, is effected in the usual way by contact rings H and the commutator G, provided with tangential contact brushes K, K. Such commutation of the currents through the coils C would be required if the apparatus were used as a direct current machine.

In using the apparatus as an *alternate* current machine, the electro-magnets C, C are excited by a separate dynamo-machine of the ordinary Siemens construction. The general view of this dynamo-machine, and also of the machine just described, which are together capable of burning 16 Jablochkoff candles, are shown by figs. 3 and 4 respectively.

The dynamo-machine, if used separately, will produce a light equal to 1,400 standard candles.

FIG. 1.

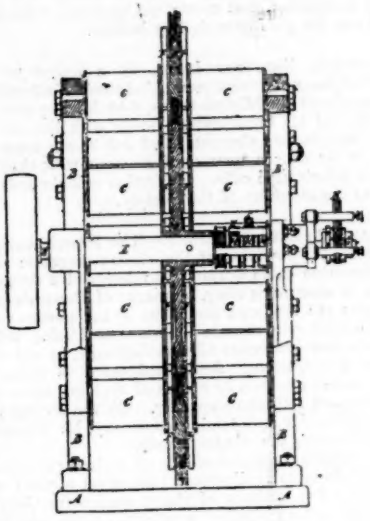


FIG. 2.

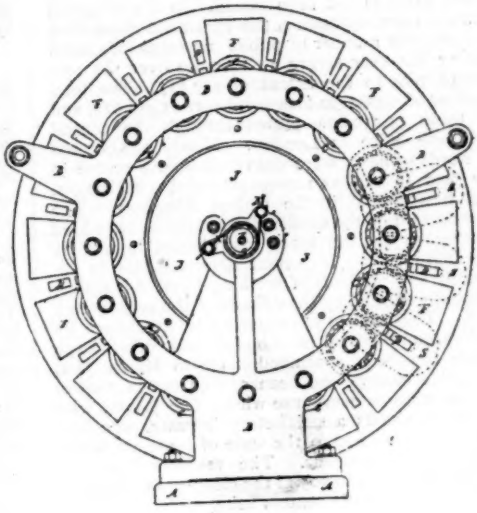


FIG. 3.

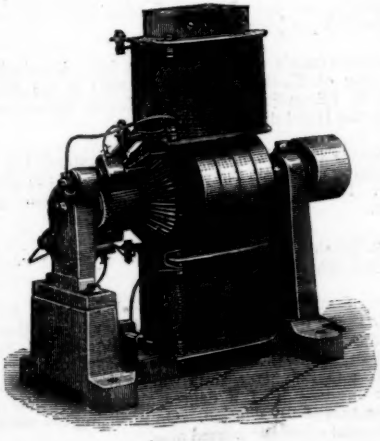
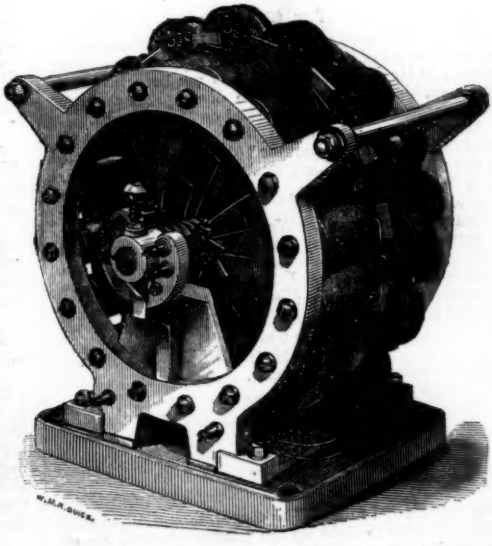


FIG. 4.



THE POSTAL TELEGRAPH DEPARTMENT.

THE twenty-fifth report of the Postmaster-General on the Post Office for the financial year ending March 31st has just been issued. In the telegraph branch, notwithstanding the continued depression in trade, the number of public messages forwarded during the year shows an increase over the preceding year to the extent of 317,617. The total number of messages forwarded was 24,459,613, and of these 11,240,609 passed through the central telegraph office in London. Nearly 286,000,000 of words of news were delivered in the course of the year to various newspapers, clubs, exchanges, and newsrooms in the United Kingdom. The introduction of the quadruplex apparatus has added another to the fast-speed instruments in use by the Department. Important improvements in apparatus and methods of working have, it is stated, also been effected by the officers of the engineering staff. The process of superseding overhouse by underground wires in London and other large towns has been continued. Up to March 31st, 1879, this change had been carried out in respect of 320 miles of overhouse wire. The private wire business exhibits a satisfactory increase, especially when regard is had to the state of trade, on which it so greatly depends. The revenue from this source stood at £63,305 at the close of the financial year, the number of renters being 1,889.

Correspondence.

A DUPLEX SYSTEM WITHOUT CONDENSERS.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—Replying to a question by "Indian Telegraph" in your Journal of the 15th inst., you say that *no* duplex system, as far as you are aware, has yet been invented which enabled condensers to be dispensed with when the apparatus comes to be worked on long circuits.

Allow us to inform you that "Theiler's Patent Mechanical Duplex Apparatus" (described in your issue of the 15th June) has been worked with *perfect success* on a line 330 miles long, without any condensers or equivalents to condensers, and with *less* than the ordinary battery power. We are, therefore, supported by actual fact and not by a theory only when we assert most emphatically that a duplex system without condensers *has* been invented, and we shall be happy to demonstrate that fact, on *any* land line, to parties in want of such a system.

Yours truly,
M. THEILER & SONS.

86, Canonbury Road, London,
25th *August*, 1879.

Notes.

THE ELECTRIC LIGHT.—The corporation of Blackpool have arranged to light up the promenade with six of Siemens' electric lights, representing 6,000 candle-power, at a cost of £2,500. The cost is to extend over three years. The light will soon be in operation, and will be kept on for twenty weeks every summer.

A COMPETITIVE trial of the electric light, as supplied by the British Electric Lighting Company, and gas-light, has taken place at the Picton Reading Room, Liverpool, and resulted in favour of the former. The cost of the electric light proved to be one-third of gas; and it is expected that money will be saved in binding, by its use, for gas fumes destroy leather.

REYNIER'S ELECTRIC LAMP.—In a report to the *Société d'Encouragement pour l'Industrie Nationale* of France, Count du Moncel states, that M. Reynier can light five of his incandescent lamps with the current from thirty Bunsen elements; and that he can keep one lamp lit for over a quarter of an hour with three of Plantés polarization cells. He further recommends the lamp to the attention of the Society.

TOMMASI'S ELECTRIC LIGHT.—The French marquis, Tommasi, the inventor of the electro-magnetic relay for submarine cable working, has designed a domestic system of electric lighting, by means of Bunsen's cells. The cells are rendered innoxious by the porous vases being hermetically closed; the nitric acid being fed to the cells from reservoirs filled periodically, by aid of a syphon arrangement. Acidulated water is delivered to the exterior vessels by means of syphons also; and the zincs are self-amalgamating. On the strength of these devices for maintaining constancy, M. Tommasi calls his battery the *pile perpetuelle*.

The lamp is composed chiefly of an iron pipe about three centimetres in diameter, turning on a pivot, and containing five carbons of thirty centimetres length, which, one after the other, in rotation, enter into contact with a disc of carbon forming the negative pole, and thus produce a light during eight or ten hours. The rods are pushed toward the disc by the buoyant power of mercury, and are said to yield a very steady light. The whole size of the lamp does not exceed that of an ordinary Carcel burner. It has been tried in Paris at several places with success. The cost of an apparatus, including lamp and fifteen Bunsen elements, capable of giving a light equal to thirty-six candles, or six gas jets, is 500 francs (£20). The consumption of nitric acid is about one litre a day (requiring two litres of water); and that of carbon is from fifteen to twenty centimetres per hour.

JABLOCHKOFF'S electric light has been installed on the quay of Blankenberghe (Belgium); at the Alpine hotel de l'Engadiner Kulm, St. Moritz, Switzerland; and at the Hotel du Parc, Luchon.

RAPIEFF'S electric light has now been extended to the composing as well as the printing rooms of the *Times* office. It will also be introduced into a Russian light-house.

THE Brush Electric Light Company have already sold over 500 lights for actual use.

TEMPERATURE OF ELECTRODES.—It has been found by M. Bouty that when sulphate of copper solution is decomposed by the current from one Bunsen cell, flowing between metalised thermometers as electrodes, the negative thermometer rises whilst the positive falls about one-twelfth of a degree above and below the temperature of the solution. On reversing the current, the thermal effect is reversed also.

A WIRE CONTACT BREAKER.—Dr. F. Niemoller constructs a simple and rapid contact breaker by stretching an iron wire horizontally and attaching to it a platinum point which touches a mercury surface.

The current is passed through the wire and mercury, and also through a small electro-magnet placed over the wire. The magnet attracts the wire below as an armature and thus breaks contact with the mercury. The circuit being broken, the current ceases to flow and the wire swings back to its old position, carrying the point into contact with the mercury again. This re-establishes the current, and again the contact is broken. By varying the tension and length of the wire, the number of vibrations per second can be altered: as many as 1,000 breaks per second being obtainable.

MAGNETISING FLUID CAST-IRON.—Mr. E. Chernoff has magnetised a bar of molten pig-iron by surrounding the mould in which it was cast by an electro-magnetic helix. The result was a magnetic bar of cast-iron, having a symmetrical cavity extending about two-thirds of its length, the metal being extremely thin just opposite the centre of the reel. While pouring in the metal, and until it had set, the experimenter noticed a singular agitation in it, and the hollowness of the bar after cooling is supposed to be a result of this disturbance. It is suggested that powerful permanent magnets of cast-iron may be formed in this way by casting under pressure, or in the form of hollow pipes.

THE Lord Mayor has received the cross of the Legion of Honour from our polite neighbours in recognition of his hospitality to the members of the International Telegraph Conference and of the Literary Congress.

THE TELEPHONE COMPANY are about to introduce Bell's telephone into London on the exchange system.

EDISON'S TELEPHONE is also to be introduced into Paris on the exchange system, permission from the Municipal authorities having been obtained.

THE new torpedo ship *Polyphemus* will be fitted with elaborate electric lighting apparatus.

WE hear that Mr. Simpson, who was so successful in asserting his claim to the patent right for application of gutta-percha as a telegraph wire insulator in the United States against the Western Union Company, is possessed with the intention of challenging the cable companies for using that material without his permission. Mr. Simpson is probably inflated with his American triumph; but he had better let that content him.

THE American Union Telegraph Company, the new rival to the Western Union Company, is progressing rapidly with its lines, and expects to open for business on or about the 1st of October.

THE yellow fever epidemic at Memphis, Tennessee, is again causing some mortality amongst telegraphic operators; but not so much as during the plague of last year.

WE are desired by Mr. Johnson, assistant to Mr. Edison, to state that it is not as Mr. Edison's European representative that he has arrived here, but as his engineer. Colonel Gouraud is Edison's only representative in England.

THE PHONEIDOSCOPE of Mr. Edmunds has re-appeared in France under a new name, and been made the subject of a lecture by M. Geraldy, at the Salle des Capucines, Paris. It was exhibited with the Gower telephone, and is reported to be the invention of a M. Coulon, conservator of the Industrial Museum, Paris. Several of our contemporaries, oblivious of the fact that they have recently described it in their pages under another name, are conspicuously hailing its effects as a *transformation of sound into light*. We are riding this transformation of energy hobby so far just now, that a dog howling at the moon will soon be spoken of as an instance of the transformation of moonshine into consciousness.

A SUBTERRANEAN line has been laid from Hamburg to Bremen, Oldenburg, and Emden, with branch lines to Bremerhaven and Wilhelmshaven.

THE lines of the Dominion Telegraph Company of Canada have, we hear, been leased to the American Company for 99 years from the first of July ult., and should the lessees in any way fail to carry out their agreement to pay over quarterly dividends, interest on bonds, &c., the Dominion Company at the expiration of 30 days, are empowered to terminate the lease.

A MONUMENT to Arago was recently unveiled at Perpignan.

A SINGULAR case of lightning-stroke occurred lately at Altorf, during the performance of the opera of Lucie. In the malediction scene, a thunderstorm burst and the tenor was suddenly struck down by the discharge, but happily not quite killed.

FEMALE TELEGRAPHISTS.—There are only 81 female clerks employed in the German Imperial Telegraphs, and these are confined to the Duchy of Baden, having been taken over at the transfer to the Government. These are to be gradually superseded by male clerks as vacancies occur. In our own central station there is also a tendency to limit females to the Metropolitan work in London, as males are found to stand the strain of provincial and foreign traffic better.

ATMOSPHERIC ELECTRICITY.—M. Denza has reduced the data of twelve years' readings on the Palmieri and Bohnemberger's electrometers at the Moncalieri observatory, with the following results:—The development of electricity depends on the combined action of the vapour of water and the heat of the sun. In Piedmont there are two diurnal maxima of electrification succeeding the rise and set of the sun by several hours; in winter they are later than in summer. There is a minimum between these corresponding to the passage of the sun across the meridian. The annual maximum is near the end of winter, in February, decreasing to a minimum in September. During summer the electrification oscillates, because of storms. The annual mean follows the period of magnetic variations and solar spots. Before and after storms the potential of the atmosphere is very low, the electrometer marking almost zero. Snow and rain, and in a less degree thick fogs, hoar frost, glazed frost, and the formation of clouds make it increase.

In a calm sky, and especially when heat is united to serenity, there is very little electricity noticeable. South-east winds increase the electricity of the air; but north-winds do so much more feebly. In strong winds the indications are uncertain. During the whole twelve years of the observations negative electrification has been present 50 out of 100 times, at least with snow and rain. Rain and snow in falling pell-mell give either positive or negative electricity. Negative electricity sometimes precedes or follows storms. When the sky is cloudy or clear the electricity is always positive. When it is negative it is due to foreign causes, as for example storms or distant rains, or

aurora, or formation of clouds, &c. Lastly, the electric tension, under normal conditions of atmosphere, diminishes with the altitude.

ACTION OF LIGHT ON BATTERIES.—It was discovered by Edmund Becquerel that light influenced the electro-motive force of certain batteries; and M. Pellat has recently observed that light affects a Daniell cell in which the copper plate is oxidised, or has a salt on its surface, whereas if the copper is very clean no alteration ensues. Two standard Daniell elements, of which the coppers were coated with verdigris, gave constant electro-motive forces (1·15 volts for the one, and 1·11 volts for the other) during five months when tested in the shade; but when exposed to the sun they lost $\frac{1}{10}$th of their electro-motive force. The loss was very rapid, but it ceased on interposing an opaque screen between the battery and the solar rays.

The phenomenon is not due to a rise of temperature, for immersion of the cells in water at 50° C. produced no sensible effect on its difference of potential. Besides, a red glass screen, which cut off the blue rays, had the same effect on the battery as the opaque screen aforesaid. On the other hand, a vessel containing a solution of celestial blue, allowing only $\frac{1}{3}$th of the heat rays to pass, transmitted $\frac{1}{4}$th of the efficacious rays, thus proving that more refrangible rays are the active ones. Concentration of the sunlight on different parts of the cell has led the author to the conclusion that it is only the altereo copper plate, and sulphate of copper, which is sensitive to light. The luminous action renders these less electro-negative to the zinc.

ACTION OF MOVING MAGNETISM ON STATIC ELECTRICITY.—Prof. Rowland, as is well-known, established the fact that a body charged with static electricity and in motion, acts upon a magnetic needle as does a current. It is upon this discovery that the Perry and Ayrton theory of the earth's terrestrial magnetism is based. The reverse effect has recently been shown by M. Lippmann to the French Academy of Sciences, who finds that the movement of a magnetic field produces on a small body charged with a unit of electricity, a mechanical force equal in amount and direction to the electro-motive force at the same place. It results from this fact that static electricity possesses a proper mechanical inertia which adds itself to that of the body electrified; and M. Lippmann further points out that an electrified body in movement gives rise to a magnetic field whose intensity is proportionate to the speed, and variation of intensity to the acceleration of the body. Contrarily, the variation of a magnetic field produces on an electrified point, a mechanical force equal to the electro-motive force of induction, and consequently proportional to the speed of magnetic variation ratiocinate to the acceleration of the bodies and directed according to the acceleration. But a mechanical force thus directed, and proportional to the acceleration constitutes what is called a *force d'inertie*. The ratio of the force to the acceleration is a quantity which is constant for the same electric charge, but which is not simply proportional to the quantity of electricity. Electric inertia is no new idea, as M. Lippmann seems to think, for it was given out by Sir W. Thomson years ago.

CAPACITY OF VOLTAIC POLARISATION.—In charging a polarisation battery, a certain quantity of electricity is necessary to bring the electro-motive force of the latter the same as that of the source or charging battery. M. Blondlot has recently investigated this subject, with a view to measuring the quantity in question, and he finds that there is no strict proportionality between this quantity and the electro-motive force of polarisation, but there is an approximate proportionality for feeble electro-motive forces. For higher electro-motive forces, the charge increases more rapidly than the polarisation, in such a manner that, if the phenomenon be represented by a curve, having for abscissæ the electro-motive force, and for ordinates the true charges, the curve is convex towards the abscissæ. The capacity of voltaic polarisation may therefore be defined as a function of the electro-motive force, which is represented graphically by the angular co-efficient of the tangent of the curve in question. M. Blondlot further arrives at the law, which may be thus stated:—For a given electrode and a given electrolyte, the initial capacity does not depend on the direction of polarisation.

HERR WESTPFAHL has applied to the authorities at Berlin for permission to construct tramways in that city, on which he proposes to use electricity as motive power.

A NEW THEORY OF THE EARTH'S MAGNETIC POLES.—From a study of the movement of the compass-needle producing declination at London, Mr. B. G. Jenkins, of the Royal Astronomical Society, has become convinced that the various vicissitudes of the needle during the last 300 years can best be explained by the supposition of a strong magnetic pole above the earth's surface, and revolving around the geographic north pole in about 500 years. He finds four magnetic poles, as maintained by Halley and Handsteen, to be necessary to explain satisfactorily all the phenomena of terrestrial magnetism, but he places these not in the earth, but in the atmosphere. These poles he regards as the free ends of as many broad magnetic belts, two extending from the vicinity of the north pole to the equator, the other two coming up from the south pole to meet them, the boreal magnetism of the northern belts uniting with the austral magnetism of the southern belts along the magnetic equator. These bands he believes to revolve at slow and unequal rates round the poles of the earth, producing secular variations. On this hypothesis, the pointing of the south pole of a magnet perpendicularly to the ground in Boothia, as observed by Sir J. Ross, is explained by supposing that it was really repelled by a like pole in the atmosphere overhead. Mr. Jenkins further calculates that the alleged magnetic pole is no longer in Boothia, but in lat. 72°, long. 115°, a point which lies in Prince Edward's Island.

AN ELECTRICAL MAIDEN.—We are getting accustomed to all sorts of electrical curiosities now-a-days, electric drills, stone dressers, harps, signboards, and a hundred other novelties. These are for the most part mechanical, however, and there is something startling, not to say shocking, in the announcement of an electric girl, 19 years old, recently made by a Canadian paper, the Boudon *Advertiser*. She has, it appears, just recovered from a two years' illness, the nature of which the doctors were unable to determine, as there did not seem to be any organic complaint, and has developed such wonderful electrical powers, that she seems to be a perfect battery. A person, unless possessed of the very strongest nerves, cannot shake hands with her, nor can any one place his hand in a pail of water with hers. By joining hands she can send a sharp shock through fifteen or twenty persons in a room, and she possesses all the attraction of a magnet. If she attempts to pick up a knife the blade will jump into her hand, and a paper of needles will hang suspended from one of her fingers. She cannot drop any light article of steel she may pick up. On her entering a room a perceptible influence seizes all others,

and while some are affected to sleepiness, others are ill and fidgety till they leave. A sleeping babe will wake up with a start at her approach, but with a stroke of her hand she can at once coax it to slumber again. Animals also are subject to her influence, and a pet dog of the household will be for hours at her feet as motionless as in death. Articles which she uses become magnetised. Now, it appears to us that this young lady is valuable, and we marvel that the Americans have not discovered that there is "money in her." It is clear that she cannot fulfil the usual destinies of her sex and become a wife, since no man would have the intrepidity to kiss her. But nature has not, therefore, left her functionless, and if Mr. Edison cannot utilise her as generator for the production of his electric light, she might prove an inestimable treasure in the service of electro-medicine.

ELECTRICITY AND VEGETATION. — M. Grandeau, whose researches on the growth of plants in an electrified atmosphere, we noticed in a recent number, has also found from simultaneous experiments at Nancy and Mettray (Indre-et-Loire) that the fostering effect of the electricity is felt in the flowering and fruition of plants as well as in their growth. Two like tobacco plants were under similar conditions, with the exception that one was placed under a metal cage while the other flourished in the open air. That in the open air exposed to the influence of atmospheric electricity, produced 89 flowers, of which only a few were *epanoui*, and attained a total weight of 1150 grammes; while that screened from the atmospheric electricity only put forth 45 flowers, of which nearly one-third attained a total weight of 860 grammes. Further the free plant flowered earlier than the enclosed one.

Another experiment consisted in rearing three tobacco plants, one in the open air, the second under a cage, and the third under the shade of a *maronnier* tree. The first bore 41 seed capsules, the second 20, and the third 20. The tree here acted as a cage. Plots of maize were also cultivated with and without an electric screen, and the results showed an increase of nearly one-third in the total quantity or grain produced.

LOSS OF CHARGE.—Herr Narr, a German physicist, from experiments made on an electrified body insulated in gas enclosed in a conducting envelope connected to earth, states his result that the loss of charge by the body is due to two distinct processes, the first one of rapid intense outflow, the other of slow and feeble dispersion. The intensity of the former increases with decreasing density of each of the gases (carbonic acid and hydrogen) used, and also on substituting H for the CO_2, the density remaining the same. The difference between the gases decreases with the density. Herr Narr concludes that the condensed layer of gas on the charged conductor behaves as an insulator, not as a conductor.

COMPOSITION OF GASES BY THE ELECTRIC SPARK. —M. Berthelot finds that two volumes of hydrogen mixed with one volume of oxygen will not combine to form water under the influence of a spark from 7 to 8 centimetres long; although in increasing the tension progressively to the point of disruptive discharge water is formed.

SEVERN'S ELECTRICAL TELL-TALE COMPASS.—This ingenious compass, which was recently on view at Lloyd's office, is designed to enable the captain of a ship to *hear* when she is off her true course. It is contained in a small box, is easily shifted about, and is meant for the captain's cabin, or any other convenient place. An adjustment can be made by the person in charge, whereby an allowance to port or starboard (of any angle) can be made within which the vessel may be steered without alarm being given; but, should the vessel exceed the allowance determined upon, the alarm-bell instantly rings, and will continue to sound until the proper course is resumed, or the alarm liberated. The alarm-bell can also be disconnected at will; and the compass used as an ordinary one. It is claimed that coasts, rocks, and shoals may be better guarded against, officers made more attentive, and men more careful in steering by the use of this instrument, and that the vessel's course will be straight. When vessels are riding at anchor in roads or harbours the tell-tale can be set to make known any swinging of the ship by day or night.

AN ELECTRIC WATCH ALARM.—We learn from *Les Mondes* that the Abbé Ivamors Hà de Bruno, professor of mathematics at Turin, has devised a small pocket *reveil*, which can be applied to watches to remind or wake a person at any desired hour. It is patented in several countries, and is constructed by M. de Bayeux, 41, Rue des Blancs-Manteaux, Paris. Price 16 francs.

THE NEW THEORY OF THE EARTH'S MAGNETISM.— It will be remembered that at the meeting of the Physical Society, on June 29th, Mr. H. A. Rowland, Prof. of Physics in the John Hopkin's University, Baltimore, pointed out supposed error in the calculations by which Profs. Ayrton and Perry sought to establish their new theory of terrestrial magnetism. At that time, Prof. Rowland had not seen these calculations in full, so that he could not say exactly where the error occurred; but in the *Philosophical Magazine* for August, he, having at length seen their full working out, is able to point out the mistake, which according to him is in the sign of an exponent, where $+\frac{1}{2}$ should be $-\frac{1}{2}$. According to the correct results the earth in order to account for its magnetism by the new theory, would require to be electrified to a potential of about 41×10^{15} volts., a charge which would be sufficient to produce a spark in atmospheric air of ordinary density of about 6,000,000 miles. "It was," says Prof. Rowland, "this large quantity which caused me to reject the theory; for I saw what an immense effect it would have in planetary perturbation; and I have even imagined to myself the atmosphere flying away, and the lighter bodies on the earth carried away into space by repulsion. And, doubtless, had not Profs. Ayrton and Perry made some mistake in their calculation, by which the force was diminished 16×10^{16} times, they would have feared like results. For according to Thomson's formula, the force would be equal to a pressure outwards of

$$r = \frac{v^2}{8\pi a^2}$$

which amounts to no less than 1,800,000 grammes per square centimetre! or 10,000 kilos. per square inch! Such an electrostatic force as this would undoubtedly tear the earth to pieces, and distribute its fragments to the uttermost parts of the universe. If the moon were electrified to a like potential, the force of repulsion would be greater than the gravitation attraction to the earth, and it would fly off through space. For these reasons I rejected the theory, and now believe that the magnetism of the earth still remains, as before, one of the great mysteries of the universe, toward the solution of which we have not yet made the most distant approach."

But what if the earth's magnetism be the resultant of several causes, and the electrostatic charge of the surface, according to Profs. Perry and Ayrton, one of them?

New Patents—1879.

3272. "Electric lighting apparatus." W. R. LAKE (communicated by Dr. L. Concornotti). Dated Aug. 13.

3355. "Manufacture of electrodes for the production of electric light." W. MORGAN-BROWN (communicated by P. A. Parlier). Dated August 20.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.—1878.

5257. "Induction apparatus." J. H. JOHNSON. Dated December 24. 2d. This consists in distributing electric currents for lighting, and other purposes, by means of an electro-magnet coil, inducing currents in other electro-magnets set near. (*Not proceeded with.*)

5313. "Telegraphic recording apparatus." R. K. BOYLE, New York. Dated December 30. 6d. This describes a recorder in which the moving part is a needle inside a hollow coil. The needle is connected to a platinum index which moves from side to side as the needle is deflected by the current; the position of this pointer determines the flow of a succession of induction sparks, which pierce and mark the signals on a running strip of paper.

5321. "Underground telegraph lines." J. S. PIERSON, Brooklyn, New York. Dated December 30. 6d. These lines are formed by grooved boards in which wires are laid, and then covered with bitumen, &c.

1879.

4. "Obtaining writings, &c., for printing, by means of electricity." A. BROWNE (communicated by G. P. L. Beleel and C. H. O. Hallez d'Arroz, Paris). Dated January 1. 6d. This consists in making a stencil of a writing or sketch by means of a metal point discharging induction sparks through the paper to a metal plate beneath. The stencil thus obtained may be transferred to stone by inking a sheet of paper with transfer ink, and placing the stencil thereon, and covering it with a sheet of white paper, and pressing it sufficiently for the ink to pass through the holes in the stencil.

27. "Electric Lighting." B. A. RAWORTH. Dated Jan. 3. 6d. The continuous cleansing of the commutators of dynamo-electric machines from metallic particles is herein effected by means of brush contact to which is imparted a rotary or reciprocating motion. The application of a magnetic alarm to dynamo-electric machines to warn an attendant or stop the machine on the occurrence of any break or decided diminution of the resistance of the circuit is also described. Mercury resistances controlled by electro-magnets are used to regulate the current; and a regulator lamp for the arc is described in which the usual fly is replaced by a copper disc revolving between the poles of an electro-magnet.

58. "Galvanic Cells and Batteries." WENTWORTH ERCK. Dated Jan. 6. 6d. The vessel consists of a long narrow and shallow trough of lead. The sides are lined with the carbon plates and into the narrow space between the carbons the zinc plate is inserted; the space between the zinc and carbons not exceeding $\frac{1}{16}$ inch. Bichromate solution from a reservoir flows in at one end of the trough and out at the other. In a second arrangement the plates take the form of circular discs which are mounted on an axis with a vulcanite washer between and rotated within the solution so as to give a continuous current.

65. "Electric lamps." A. M. CLARK (communicated by Eugene Ducretet, Paris), Dated Jan. 6. 4d. This lamp consists of a modified Werdermann in which the lower carbon pencil is floated in mercury up against the larger upper carbon. (*Not proceeded with.*)

81. "Electric lamps." W. K. HEDGES. Dated Jan. 8. 6d. Two carbons descending as they waste along guide tubes rest their lower ends on a piece of refractory matter and yield the arc between these ends of which the distance apart is regulated by mounting the guide of one carbon on a rocking transverse axis controlled by a spring, which is in turn controlled by an electro-magnet in circuit with the current.

83. "Electric lamps." W. LADD. Dated Jan. 8. 6d. In this lamp the holders of both the upper and lower carbon points have an advancing and receding motion, for the purpose of bringing the points together and retracting them to complete the electric circuit and to produce the light and regulate its intensity. The holder of the lower carbon consists of a tube which is free to slide vertically in guides in a metal framing. This tube is slotted longitudinally to admit within it a portion of the periphery of a grooved pulley, to which is attached a cord that depends therefrom into the tube, and carries at its pendant end a weight that is free to move in the tube. This weight as its cord is wound on to the pulley comes into contact with a stud projecting inwards from the tube and by this means the tubular carbon holder receives a tendency upwards, Surrounding the lower part of this tubular carbon support is a solenoid or coil of copper wire, one end of which is in metallic connection with the frame of the lamp, the other end being in direct connection with the source of electricity.

144. "Electric Lighting." W. MORGAN-BROWN (communicated by Col. W. F. C. McCarty and Baron Raymond, Sellière, Paris). Dated Jan. 13. 6d. The electrodes in the lamp herein described are of carbon, or platinum, &c., composition, and they are inclined at an angle to each other as in Rapieff's lamp. The light is rendered white by inserting in it a piece of pure calcium or a pellet of an alloy of platinum and iridium. Globes for the lamp are formed not of opaque glass but of two concentric spheres of transparent glass with a shell of water between.

178. "Obtaining Light by Electricity." AUGUSTE DE MERITENS. Dated Jan. 15. 2d. Two semi-cylindrical parallel carbons are placed far enough apart to admit a third carbon with parallel sides. The outer carbons are connected in circuit and the middle one is insulated; but its tip is kept incandescent by the arc. (*Not proceeded with.*)

192. "Preventing rapid destruction of the Electrodes used in Electric Lighting." GEORGE REMINGTON. Dated Jan. 16. 2d. This consists in surrounding electrodes with non-oxygenated gas, or steam or liquids are employed to keep them at a temperature below that at which combustion usually takes place. (*Not proceeded with.*)

City Notes.

Old Broad Street, August 26th, 1879.

ANGLO-AMERICAN TELEGRAPH COMPANY, LIMITED—The ordinary half-yearly general meeting of the proprietors of this company was held on Friday, August 8, at the City Terminus Hotel, Cannon-street, Viscount Monck, the Chairman, presiding.

The Chairman, in moving the adoption of the report and accounts to the 30th June, said he was glad to state that, notwithstanding the depression which they were

all aware still, unfortunately, continued in most branches of commercial enterprise, their traffic within the last half-year had been very prosperous. There had been an increase in the half-year at the rate of about £50,000 a year, and they would have found the very pleasant indication of that fact in the addition which the Board had been able to give to the interim dividend —of ½ per cent. more than they had been in the habit of giving. That, he thought, was a tangible proof—though he did not know that they required to have it given them—of what he had often stated from the chair—that the directors were desirous of distributing among the proprietors every shilling of money they earned, which they believed was not absolutely necessary for maintaining the credit and permanence of the enterprise. So far with regard to the earnings of the past half-year; and he might state that those of their cables which were in working order were working satisfactorily, and were carrying the traffic in as efficient a manner as ever. The cable of 1869, which broke down some time in the spring, was being repaired as rapidly as possible. They had every reason to believe and hope that they would finish the repairs satisfactorily; but the truth was that the exceptional character of the season, which was the continual subject of conversation here, had prevailed also on the other side of the Atlantic, and the fogs were such that it had been almost impossible for the ship to go to sea for a sufficient time to repair the cable; but there had been no failure in the attempt to repair it. So far as they had gone they had been fully successful, and he had very little doubt, if the weather changed, and became what would be satisfactory to them, that they would succeed in the attempt. With regard to the accounts, if they referred to the abstracts that had been furnished for the last two half-years, in compliance with the promise made about a year ago to the shareholders, they would find that the expenditure of this half-year appeared to be about £4,575 larger than that of last half-year; but, on the other hand, there were items in the accounts of this half-year which were less than the corresponding items of last year, and reduced to the apparent balance against them by £2,398, leaving a balance of £2,177 to be accounted for as the increace in the present half-year. There had, however, been certain extraordinary charges in the half-year, which entirely accounted for the increase, and, when he mentioned them, he thought they would say that they were not to be questioned. In the first place, there was an increase in the article of stationery of £200. This might seem a very large increase, but it was entirely owing to the fact that they were obliged to call an extraordinary meeting, and the expenses of sending out circulars and printing amounted to that sum. Then there was £500 for the entertainment of the International Telegraph Conference which had been sitting in London. All the other telegraph companies contributed their share towards the entertainment of those gentlemen, who came to this country from all parts of the world to arrange the international administration of telegraphy. When the conference was held in other capitals our delegates were treated with the greatest possible kindness and hospitality; and he was certain that the shareholders would not have considered it right that their Company should not co-operate with the other companies and with the Post Office department of the Government in receiving those foreign gentlemen when they came to England in a manner worthy of the country. That, then, accounted for £700 of the increase. Under the head of "maintenance of land lines, instruments, and instrument stores," they would see an increase of £1,600, and that was owing to the fact that electrical instruments, like all other human things, wore out, and they had been obliged to send out to foreign stations entirely new sets of instruments, which accounted for the expenditure. That accounted for £2,300 of the nett increase in the half-year; but, in addition to that—and which showed at once that, so far from being a real increase in the expenses of the half-year, there was, in fact, a diminution—there was another item, an extraordinary item, of £1,000 for new buildings at Valentia. Therefore, instead of there being an increase in the half-year, when they came to deduct the economies effected, and these large extraordinary expenses, which were absolutely necessary and inevitable, they found that the expenditure was less, and had been more economical than for the previous one. The reserve fund, or renewal fund, as they were aware, was being increased at the rate of £150,000 a year, and, at the end of this year, would amount to half a million of money. They had applied the duplex system to their cables, and they had found immense benefit from it. He was not quite sure whether the word "duplex" was realised —that they could carry double the amount of traffic, but it allowed them to carry an enormously increased traffic on the same cables they had hitherto been working. He now came to what was really the most important point touched on in the report, and that was the policy of laying another cable next year. With respect to that question, they must remember two things. In the first place, they must endeavour to maintain the position of this Company as the most powerful and the most efficient company for the purpose of telegraphy in this country. In order to do that, he thought they ought never to allow themselves to get below the position of having three cables at their command. Fortunately for the policy which the Board had pursued steadily, they were in a position to realise these views without asking for a single shilling of money from the shareholders or any one else. He had already told them that the reserve fund at the end of this year would amount to half a million of ready money, including the cable in store. In addition to that, they had the shore ends of the cables of 1865 and 1866, which were in perfectly good order, and which, they were all aware, were a very large proportion of the expense of laying down a cable across the Atlantic—the shore ends were, in proportion, the most expensive part of a cable. They could use these shore ends at both sides, and all that they would have to provide was the deep sea-cable, and he believed they could do that for less than the amount at their credit. He did not know whether he had said enough to commend this policy to their judgment. He confessed that he himself thought it was absolutely necessary and desirable that they should adopt it, and that they should keep themselves in the position of a company bound to maintain two cables, but still with the power in reserve of a third cable, in case of any accident or casualty. So much for the policy which they meant to adopt in future with regard to their cables. At their last general meeting, it was proposed to establish a superannuation fund for their officers by an arrangement with an assurance company. The arrangement was that their Company was to pay half of the premium necessary to obtain the superannuation, and that the officers, out of their salaries, were to contribute the other half. He explained the whole system at the last meeting, but a question was raised in the room as to the propriety of taking that step at the moment. He did not think there was any opposition on principle to the project, but the question was raised as to whether that was the proper time for doing the thing, and the Board agreed to postpone the adoption of the system until the next half-yearly meeting, and to issue proxies to the proprietors generally upon that very point, and ask them to give their votes on it. They had adopted that policy, and

he held in his hand the return made to them in answer to that appeal. In round figures the votes in favour of the project were £1,251,333, and against it £22,328, and, therefore, having taken the course which was suggested at the meeting, and accepted by the Board, they found that the proprietors of the Anglo-American Telegraph Company, by an overwhelming majority, had decided that the proposition of the Board should be adopted. He then moved the resolution for the adoption of the report and accounts. The resolutions having been seconded, and some queries made by several of those present, Mr. Walker asked if the Board had any information as to the probability when the new French cable would be laid, and how the work was going on. The chairman said he believed they were going on as fast as they could. He had no official information on the subject. He was not in amicable relations with them, and they did not confide their secrets to him (laughter). A shareholder asked what the new cable, which the Board proposed to lay, was likely to cost? The chairman said they had no estimate. In fact, they had done nothing except adopt the policy. He then put the resolution for the adoption of the report, and the motion was carried unanimously. Continuing, he submitted a resolution approving the establishment of the endowment assurance fund, and authorising the Board to carry the arrangement into effect, as expressed, or with any modifications which the Board from time to time might require or approve. A director having seconded the motion, the chairman put it in the usual manner, and declared it carried by 24 to 13. The majority of the meeting, therefore, did not take part in the voting.

THE CUBA SUBMARINE TELEGRAPH COMPANY, LIMITED.—The half-yearly meeting of the shareholders of this Company was held August 20th, at the office, 61, Old Broad Street, Mr. T. Hughes, Q.C., in the chair. The Chairman moved the adoption of the report (an abstract of which appeared in the TELEGRAPHIC JOURNAL, of August 15th), and said that in ordinary times telegraph companies looked forward yearly to something like an increase of 10 per cent., but the business of the Company had not increased to the extent of anything like that percentage. There had been a considerable falling off in the traffic owing to the working of the Government lines, and the falling off had amounted to about one-third. Another reason for the falling off was the want of good condition of the West India and Panama Company. Another reason was that they, as well as other companies, had suffered from the depression of trade. At all events, they were enabled to declare a dividend on the ordinary shares at the rate of six per cent., and this he considered would be a satisfactory announcement (hear, hear). Mr. De Mancha seconded the motion, which was, after a short discussion, agreed to. In reply to several questions, the Chairman stated that the line between Para and Demerara would in all probability bring them a great accession of business, and that if the interoceanic canal were constructed their returns would be considerably increased. The report was adopted, the dividend was declared, and after the conclusion of the formal business the proceedings terminated with a vote of thanks to the Chairman and Directors.

The following are the final quotations of telegraphs:—Anglo-American, Limited, 52⅝-53¼; Ditto, Preferred, 81⅞-82¼; Ditto, Deferred, 26¼-26⅝; Brazilian Submarine, Limited, 6¾-7; Cuba, Limited, 7⅞-8¼; Cuba, Limited, 10 per cent. Preference, 15½-16½; Direct Spanish, Limited, 1⅞-2⅛; Direct Spanish, 10 per cent. Preference, 11¼-11⅝; Direct United States Cable, Limited, 1877, 10-10¼; Eastern, Limited, 7⅞-8; Eastern, 6 per cent. Debentures repayable October, 1883, 105-108; Eastern 5 per cent. Debentures repayable August, 1878, 101-103; Eastern, 6 per cent. Preference, 11⅞-12⅛; Eastern Extension, Australasian and China Limited, 7⅞-8; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 105-108; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, par 1 pm; Ditto, registered, repayable 1900, par 2 pm; German Union Telegraph and Trust, 7⅛-8; Globe Telegraph and Trust, Limited, 4⅝-5; Globe, 6 per cent. Preference, 10⅞-11⅛; Great Northern, 8⅜-8⅝; Indo-European, Limited, 21-22; Mediterranean Extension, Limited, 2⅝-3¼; Mediterranean Extension, 8 per cent. Preference, 9¼-9⅝; Reuter's, Limited, 9-10; Submarine, 220-225; Submarine Scrip, 2-2⅛; West Coast of America, Limited, 1-1⅛; West India and Panama, Limited, 1¼-1⅝; Ditto, 6 per cent. First Preference 6¾-7¼; Ditto, ditto, Second Preference, 6¾-7¼; Western and Brazilian, Limited, 3-3⅛; Ditto, 6 per cent. Debentures "A," 94-98, Ditto, ditto, ditto, "B," 87-92; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 118-122; Ditto, 6 per cent. Sterling Bonds, 107-109; Telegraph Construction and Maintenance, Limited, 30½-31; Ditto, 6 per cent. Bonds, 106-108; Ditto, Second Bonus Trust Certificates, 2⅛-2⅜; India Rubber Co., 12¼-12⅝; Ditto, 6 per cent. Debenture, 103-108.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,213,900.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £495,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £683,210.
	£	£	£	£	£	£	£	£	£	£	£	£	£
July, 1879 ...	49,320	16,299	2,800	913	16,440	35,789	23,411	20,421	... ...	11,733	... ... *	10,697	4,858
July, 1878 ...	43,610	11,759	2,608	812	14,540	34,451	24,927	18,811	... ...	10,706	... ...	... ...	4,420
Increase	5,710	4,540	192	101	1,900	1,338	... ...	1,610	... ...	1,027	... ...	... ...	438
Decrease	... ...	... ...	... ...	... ...	... ...	... ...	1,506	... ...	... ...	... ...	... ...	... ...	... ...

*The Receipts of the West Coast of America Company for May were £1,025, and for June £705.